

Key G—Continued

15. No ventral fins, fishes capable of inflating themselves with air.....
 ----- Puffer and porcupine-fish families key, p. 297
 Ventral fins present; can not inflate themselves with air..... 16
16. Dorsal fin runs whole length of back, from nape to base of caudal, which it joins;
 barbel on chin; form eel-like..... Cusk (cod family in part), p. 462
 Dorsal fin occupies only one-third or less of back behind nape, leaving open space
 as long as fin between it and base of caudal; no barbel on chin; form not eel-
 like..... Mummichog family key, p. 155

Key H

Fishes as in Key G, except that at least the forward one-third of the dorsal fin is spiny (from No. 22, p. 12). There is no adipose fin behind the rayed dorsal, nor fleshy flap in front of it.

1. Rear part of dorsal fin soft rayed..... 2
 Whole length of dorsal fin spiny..... 7
2. Sides of head bony, with knobs or spines..... 3
 No knobs or spines on sides of head..... 4
3. Sides of head with conical spines; spiny portion of dorsal fin at least as long as soft
 part; body laterally compressed..... Rockfish family, p. 304
 Sides of head with low rounded knobs; spiny portion of dorsal fin considerably shorter
 than soft part; body tadpole-shaped.. Deep-sea sculpin (sculpin family in part), p. 329
4. Ventral fins much longer than pectorals; eye very large..... Big-eye, p. 261
 Ventral fins no larger than pectorals; eye not very large..... 5
5. Pectorals pointed; body much compressed..... Sea bream family key, p. 263
 Pectorals rounded; body not much compressed..... 6
6. Rear (soft) portion of dorsal fin nearly as long as anterior (spiny) part; anal much
 higher than long..... Sea bass (sea bass family in part), p. 251
 Rear (soft) portion of dorsal fin less than half as long as spiny part; anal much longer
 than high..... Cunner family key, p. 280
7. Mouth strongly oblique; no ventral fins..... Wrymouth, p. 368
 Mouth not strongly oblique; ventral fins present (very small in one species).....
 ----- Blenny family key, p. 359

THE LAMPREYS. CLASS MARSIPOBRANCHII

Except for *Amphioxus* and its allies, the lampreys are the most primitive of vertebrates, their skeletons being cartilaginous and their skulls hardly differentiated from the vertebral column. They have no true jaws, no ribs, no shoulder or pelvic girdles, and no paired fins. They are eel-like in appearance, but are easily distinguishable from the true eels and, indeed, from most of the true fishes by the peculiar jawless sucking mouth situated at the tip of the snout, and from all Gulf of Maine eels by the absence of pectoral fins.

THE HAGFISHES AND LAMPREYS. FAMILIES MYXINIDÆ AND PETROMYZONIDÆ

These two groups are easily distinguished by the fact that the hags have but one gill opening on each side, one continuous fin on the back, and several barbels on the snout, whereas in the true lampreys there are seven gill openings on each side, the fin on the back is separated into dorsal and caudal portions, and there are no barbels on the snout.

1. Hagfish (*Myxine glutinosa* Linnæus)

Jordan and Evermann, 1896-1900, p. 7.

Description.—The hag, like the lamprey, lacks paired fins and fin rays. Its skeleton is wholly cartilaginous, without bones, its mouth is similarly jawless, and its skin is scaleless. It is easily recognized by its eel-like form; by its single finfold (a fold of skin, not a true fin) running right around the tail and forward on the lower surface of the body with no division into dorsal, caudal, and anal fins; by the single gill pore on each side, just forward of the origin of the ventral finfold; by its lipless mouth, stellate in outline when closed; by the single nasal aperture at the tip of the snout; by its peculiar barbels or "tentacles," two flanking the mouth on either side and four surrounding the nostril; and by the evertible tongue studded with rows of horny rasplike "teeth." We might also mention the series of mucus sacs on either side of the abdomen, and point out that the dorsal finfold originates two-thirds and

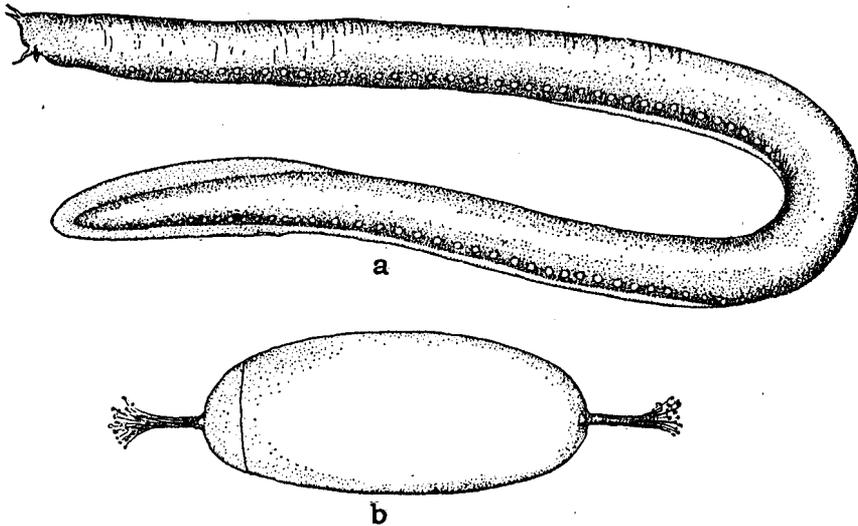


FIG. 2.—Hagfish (*Myxine glutinosa*). a, Adult. b, Egg. After Dean

the ventral one-third the distance back from snout to tip of tail, with the vent piercing it.

Hags vary in color, perhaps to correspond with the color of the bottom. They are grayish brown or reddish gray above, variously suffused, mottled, or piebald with darker or paler gray, brown, or bluish; below they are whitish or pale gray. They grow to a length of about 1 foot to a foot and a half.

General range.—Arctic seas and both coasts of the north Atlantic; south in deep waters to the latitude of Cape Fear, N. C. (33° 50' N.).

Occurrence in the Gulf of Maine.—The hag is only too common in the Gulf of Maine; perhaps it is not absent from any considerable area of smooth bottom. Thus it is abundant generally off the north end of Grand Manan, is reported from Passamaquoddy Bay and from various localities near Eastport, is to be found offshore on muddy bottom all along the Maine coast, is caught at times in considerable numbers

on the Boon Island—Isles of Shoals fishing ground and about Jeffreys Ledge, where we found it plentiful enough in the spring of 1913 to have gutted 3 to 5 per cent of all the haddock in the gill nets. Fishermen report it as equally numerous in the deeper parts of Massachusetts Bay. On the offshore banks the hag is well known, and it has been trawled at various localities along the outer edge of the continental shelf off New England at depths of from 100 to 200 fathoms, and deeper. We ourselves took 11 large ones in one set of the Monaco deep-sea trap in 260 fathoms off Nantucket on July 9, 1908, and it has been taken in from 300 to 500 fathoms off Marthas Vineyard.

Habits.—The hag is not a true parasite, as has sometimes been suggested, there being no reason to believe it ever attacks living, uninjured fish, but it is a scavenger. Judging from its habits during the brief time it survives in aquaria, it spends its time lying embedded in the clay or mud with the tip of the snout projecting, but it is an active swimmer. Probably it finds its food by its greatly specialized olfactory apparatus. So far as is known it feeds chiefly on fish, dead or disabled, though no doubt any other carrion would serve it equally well, were such available. It is best known for its troublesome habit of boring into the body cavities of hooked or gilled fishes, eating out first intestines and then the meat, finally to leave nothing but a bag of skin and bones, inside of which, or clinging to the sides of a fish it has just attacked, the hag itself is often hauled aboard. In fact, it is only in this way, or entangled on lines, that hags ordinarily are taken or seen. Being worthless itself, it is an unmitigated nuisance and a particularly loathsome one, owing to its habit of pouring out slime from its mucus sacs in quantity out of all proportion to its small size. One hag, it is said, can easily fill a 2-gallon bucket, nor do we think this is any exaggeration.

The hag is at home only in comparatively low temperatures—cooler, probably, than 50°—and this confines it to depths of 15 to 20 fathoms or more in the Gulf of Maine in summer.

Breeding habits.—The hag and its immediate relatives are hermaphrodites—the only regularly effective ones in the whole vertebrate series, except for a very few species of bony fishes. Its single unpaired sex organ first develops sperm in the rear, then eggs in the forward portion.⁸

Further than this our knowledge of its breeding habits is still of the scantiest. Probably there is no definite spawning season, but eggs may be laid at any time of the year, for females near ripeness and others nearly spent have been recorded for various months, winter and spring as well as summer and autumn, and eggs have been taken in Norwegian waters from November to May. It has long been known that the eggs are large (up to 20 mm. in length), tough-shelled, and comparatively few (only 19 to 25 nearly ripe eggs having been counted in any one fish), and that they are very characteristic in appearance, for at each end they bear a cluster of barb or anchor tipped filaments (fig. 2b). Up until 1900 none had been found about which it could be asserted without hesitation that they had been laid naturally. In that year, however, Dean (1900) described hag eggs from the northwest part of Georges

⁸ For an account of the sex organ of the hag see Schreiner (Biologisches Centralblatt, XXIV Band, Nr. 3, February, 1904, pp. 91-104). For a summary of earlier studies see Smitt (Scandinavian Fishes, 1892, p. 1205).

Bank and from the south coast of Newfoundland. Jensen⁹ described others from the neighborhood of the Faroe Islands, and since then Huntsman has recorded them from the mouth of the Bay of Fundy and Hjort¹⁰ from Norway. The eggs are demersal and stick fast in clusters to some fixed object—in Jensen's case to a Bryozoa—both by their filaments and by slime threads. Newly hatched hags have never been seen, but inasmuch as the smallest yet described (about 2½ inches long), probably not long out of the egg, already resembled the adult in external appearance there is no reason to suppose that the hag passes through a larval stage greatly different from the adult. The few egg finds thus far reported, being from 50 to 150 fathoms, point to rather deep water for the spawning of the hag. The Norwegian eggs mentioned by Hjort (taken in shrimp trawls) were on ooze bottom, but whether the hag invariably seeks this type of ground for breeding remains to be learned. I need only add that, to judge from Cunningham's experience with hags in aquaria, the females cease to feed with the approach of sexual maturity, as do so many other fishes.

2. Sea lamprey (*Petromyzon marinus* Linnæus)

LAMPREY; SPOTTED LAMPREY; LAMPER; EEL-SUCKER; GREAT SEA LAMPREY



FIG. 3.—Sea lamprey (*Petromyzon marinus*)

Jordan and Evermann, 1896–1900, p. 10.

Description.—Lampreys are very primitive vertebrates, eel-like in appearance, with soft, cartilaginous skeleton. They lack paired fins but have well developed dorsal and ventral finfolds. In the adult the jaws are so rudimentary that apparently they are wanting; the mouth is a longitudinal slit when closed, but when open forms an elliptical disk at the tip of the snout and is armed with many horny, hooked teeth arranged in numerous (11 to 12) rows, the innermost the largest. There are seven pairs of open gill slits and two dorsal fin folds, whereas the hag has but one pore on each side and only one fin. The sea lamprey (the only member of its group known from our salt waters) can hardly be mistaken for any other fish, its eel-like appearance coupled with the jawless mouth sufficing to place it at a glance.

Color.—In color the sea lamprey varies with locality, and perhaps with age and season also. It is usually described as mottled above—hence the vernacular name “spotted lamprey”—and plain tinted below. While the ground color of the upper

⁹ Videnskabelige Meddelelser fra Dansk naturhistorisk Forening i Kjøbenhavn, 1900, p. 1.

¹⁰ Fishing experiments in Norwegian Fjords, by Johan Hjort and Knut Dahl. Report on Norwegian Fishery and Marine Investigations, Vol. I, 1900, No. 1, Chap. IV, p. 75. Kristiania.

surface of the body of lampreys from Massachusetts Bay is perhaps most often olive brown mottled with darker brown or black (the dark patches almost confluent), a plain bluish variety has been described, as have lampreys with the ground color yellowish brown, greenish, reddish, and bluish. Occasionally they are plain colored, but usually variously mottled. Perhaps the color of the bottom on which they live determines the color of lampreys as it does of so many other fishes. The lower surface is whitish, gray, or a pale shade of the same hue as the ground color of the back. During the breeding season lampreys (at least the landlocked form) are described as taking on more brilliant hues, the ground color between the dark spots turning bright yellow.

Size.—The lamprey rarely grows to a length of 3 feet and a weight of 5 pounds or more. Usually, however, adults, as they run up our rivers, are 2 to 2½ feet long.

General range.—Atlantic coasts of Europe and North America, from Labrador south to Florida in the western Atlantic. The lamprey spends most of its life in salt or brackish water, but ascends fresh-water rivers to spawn.

Occurrence in the Gulf of Maine.—No doubt the sea lamprey occurs along the whole coast line of the Gulf of Maine, for it is recorded in or at the mouths of numerous rivers and streams in Nova Scotia, New Brunswick, Maine, and Massachusetts, specifically in the St. John and Shubenacadie Rivers and from the St. Andrews region in salt water in the Bay of Fundy; from Eastport, Bucksport, Casco Bay, and the Presumpscott and Penobscot Rivers in Maine; from the Merrimac River; and from various stations in Massachusetts Bay, where it has been taken from time to time attached to driftwood and to the bottoms of boats as well as fastened to fishes. In olden times lampreys entered the Merrimac River in extraordinary numbers, but hard fishing has depleted their ranks sadly. Like other anadromous fishes, though they may seem plentiful enough when condensed in the narrow bounds of river banks, the stock probably is in no wise comparable with that of the commoner schooling fishes. Certainly they are not seen very often in the open sea. Probably at one time there was a run of lampreys in all the larger streams emptying into the Gulf of Maine, and they are still to be caught in the Merrimac, Kennebec, Penobscot, St. John, and Shubenacadie, and no doubt in sundry other rivers where we, personally, have no direct knowledge of them.

Habits.—Large lampreys have long been known to run up New England rivers a little earlier in spring than do shad, possibly commencing to work upstream as early as the end of April. They appear regularly in the Merrimac in May, and are most abundant there in June, after which few if any enter. They go far upstream, even to the headwaters, where they spawn in June and July. A sea lamprey has been found to contain 236,000 ova.

For the most complete survey of the life history of the lamprey we must turn to a landlocked race inhabiting certain lakes in the interior of New York and in Ontario. Briefly, it is as follows:¹¹ Such of the lampreys as approach

¹¹ For an account of nest building and spawning, which are hardly germane to the present study since they do not take place in salt water, the reader is referred to Gago (The lake and brook lampreys of New York, especially those of Cayuga and Seneca Lakes. The Wilder Quarter-Century Book, 1893, pp. 421-493, Pls. I-VII. Ithaca), Hussakoff (Sea lampreys and their nests. American Museum Journal, 1913, Vol. 13, p. 323), and to Coventry (Breeding habits of the landlocked sea lamprey, *Petromyzon marinus* var. *dorsatus* Wilder. University of Toronto Studies, Biological Series, No. 20: Publications of the Ontario Fisheries Research Laboratory, 1922, No. 9, p. 133. Toronto).

sexual maturity run up from the lakes into small clear brooks to spawn in June. As they ripen, the two sexes become dissimilar in appearance, the males (and this is equally true of sea-run fish both in American and European rivers) developing a ridge along the back, the females a finlike crest between the vent and the caudal fin. They build nests of round stones, which they drag together with their suckerlike mouths, as has often been described and pictured in natural histories, and after spawning apparently most, if not all, die, for not only have they often been found dead but their intestines atrophy, they are attacked by fungus, and they become so debilitated that recovery seems out of the question. In short, the old tradition that no lampreys return to the sea from the rivers they ascend seems well founded.

The larvæ are very different in appearance from the adults. They are blind and toothless, with mouths and fins of different shape. They continue in this state for a period estimated at 3 to 4 years, during most of which time they live in holes or burrow in the mud or sand, hiding under stones. Doctor Huntsman informs us, however, that they have been taken in tow nets in the Shubenacadie River in Nova Scotia. They subsist on minute organisms. At the end of this larval period, when they have grown to a length of 4 to 6 inches, they undergo transformation to the adult form and structure, an event occupying about two months—August to October—and descend the streams of their nativity to the sea just before the water freezes in November or December, to live and grow there for one or two years or until they reach full size and sexual maturity. The larvæ of the sea lamprey are very abundant in the mud of flats near the mouths of small tributary streams of such river systems as the Delaware and Susquehanna, where lampreys breed abundantly, and they have been reported in the Shubenacadie (a stream emptying into the Bay of Fundy) and no doubt occur in the Merrimac and other Gulf of Maine streams.

Although lampreys spawn but once and then perish, their period of growth is so long that large ones, not yet mature, are to be found in salt water all the year round.

Little is known of the habits of the lampreys while they live in the sea further than that the mode of life centers around a carnivorous nature. Judging from their landlocked relatives and from the occasions on which they have been found fastened to sea fish, they must be extremely destructive to the latter, which they attack by "sucking on" with their wonderfully effective mouths. Usually the lamprey fastens to the side of its victim, where it rasps away until it tears through the skin or scales and is able to suck the blood. Its prey sucked dry, it abandons it for another. Probably lampreys are parasites and bloodsuckers, pure and simple, for we can not learn that anything but blood has been found in their stomachs, except fish eggs, of which lampreys are occasionally full.¹² Lampreys have been found preying upon cod, haddock, and mackerel in Massachusetts Bay, even on basking sharks, and salmon, too, are said to be much annoyed by them. When not clinging to anything they are strong, vigorous swimmers, progressing by an undulating motion in the horizontal plane, and they are said to be exceedingly aggressive in their attacks on other fishes. Occasionally they are found fast to driftwood, even to boats.

¹² "The Fisheries and Fishery Industries of the United States," by George Brown Goode. Section I, 1884, p. 677. Washington.

How far offshore lampreys wander is not known. Probably, however, most of them remain in the coastal zone, if not in estuaries, and there is no evidence that they ever descend to any considerable depth. A few were brought in from Georges and Browns Banks, however, during the early years of the Bureau of Fisheries.¹³

Since lampreys never take the hook or are captured in nets except on rare occasions they are seldom seen in salt water; only when running up our rivers are they familiar objects.

In Europe, during the middle ages, lampreys were esteemed a great delicacy—historians tell us Henry I of England died of a surfeit of them—and formerly, when they were much more plentiful than nowadays, considerable numbers were captured in the rivers of New England, particularly in the Connecticut and Merrimac Rivers. They were, indeed, regularly sought in the former until well into the last half of the past century, but for 40 years now the lamprey fishery has been hardly more than a memory except locally and in a small way for home consumption. In the salt water of the Gulf of Maine the lamprey has never been of any commercial importance; the average fisherman might not see one in a lifetime, nor is there any sale for the few picked up by chance.

TRUE FISHES. CLASS PISCES

Sharks and rays. Subclass Elasmobranchii

The most obvious external character by which all sharks and rays are distinguishable from the bony fishes is that there are five or more pairs of gill openings on either side of the neck, instead of only one. In this they agree with the lampreys, but it is a commonplace that their jaws and teeth are extremely well developed. Their skins are tough and leathery and studded with denticles (placoid scales), which but remotely suggest ordinary scales and which are not homologous with the scales of bony fishes, for both dermis and epidermis take part in their formation, instead of the former alone. The teeth of the sharks and rays are essentially such placoid scales modified and simply embedded in the gums, not in the jaws. The fins are supported at their bases with segmented cartilaginous rods, and further out by numerous slender horny fibers, instead of by such rays or spines as are to be seen in the bony fishes. All the fins are covered with the same leathery skin that clothes the body. Among sharks the tail is uneven, with the vertebral column extending out into its upper lobe, but in most skates and rays it is whiplike, with no definite caudal fin. The torpedo (p. 68) is an exception to this rule.

The skeleton is for the most part cartilaginous, the skull far simpler than it is among the bony fishes, and the gills are attached throughout their lengths to the partitions between the gill openings instead of being free, while the rear portion of the digestive tract is modified into the so-called "spiral valve" by the development of a special fold from its lining layer. Sharks are usually looked upon as the most primitive of the true fishes.

¹³ Report of the Commissioner of Fish and Fisheries for 1879 (1882), pp. 811, 812, and 814. Washington.